INFORMATION

Greater St. Louis Citizens' COMMITTEE FOR NUCLEAR INFORMATION

ST. LOUIS, MISSOURI FEBRUARY, 1959

MILK AND THE STRONTIUM 90 PROBLEM

THE United States Public Health Service has been determining the quantity of strontium 90 in milk in the St. Louis area since April, 1957. The first report showed a content of 6.5 strontium 90 units. The second, in September 1958, revealed a jump to 15.4 units – highest among the nine areas then under study. The most recent report, for the last quarter of 1958, showed that the strontium 90 content reached a record high of 20.1 units in November. It rose from 12.2 units in October and dropped to 15.6 units in December. For the three-month average, St. Louis milk continued higher in strontium 90 content than any of the other nine cities surveyed. (A strontium 90 unit is an expression of the amount of the element present per gram of calcium.)

This high content and the sharp rate of increase have caused serious concern. Because strontium 90 is readily incorporated into bone, where its radioactivity may initiate bone cancer or leukemia, parents of growing children are faced with perplexing questions. We find them asking:

- What harm is likely to be caused by the present and expected levels of strontium 90 in milk?
- Can the possible danger from strontium 90 radiation be reduced if we cut down on milk drinking?
- What else can be done to minimize the potentially damaging effects of strontium 90 in milk?

The St. Louis Dairy Council recently asked CNI to prepare a statement presenting the facts that need to be considered by those concerned with the milk problem. The full text of the statement was sent to CNI members with the January issue of *Information.* It was prepared by Drs. Walter Bauer, Barry Commoner, and Eric Reiss in consultation with Dr. James King, director of the Department of Pediatrics, St. Louis University; Dr. William G. Klingberg, associate professor of pediatrics, Washington University School of Medicine; Dr. Walter Schlesinger, director of the department of Microbiology, St. Louis University School of Medicine; and Dr. Park J. White, director of pediatrics service, Homer G. Phillips Hospital.

Four Points to Consider

The main points scored by the statement prepared for the St. Louis Dairy Council are as follows:

1. The strontium 90 level of milk is expected to rise to two to three times the 1958 level in the next 10-15 years.

Not all of the strontium 90 created by past nuclear explosions has yet reached the earth. A considerable part of this radioactive material is held up in the stratosphere from which it comes down slowly. It is predicted that the amount of strontium 90 on the earth's surface will continue to rise in an irregular fashion not yet fully understood. It will reach a peak in 1970-75 when the average amount present will be about two to three times the amount present in 1958.

2. Whether present and expected strontium 90 levels of St. Louis milk will cause medical harm cannot yet be predicted.

The International Committee on Radiological Protection has established an estimate of radiation hazard – the "maximum permissible concentration." This is the amount of strontium 90 which, it is thought, will not cause detectable medical damage even though it is held in the body for a lifetime.

At present, the maximum permissible concentration for the general population is set at 80 strontium 90 units. In order for an individual to hold his strontium 90 content down to this maximum his dietary source of calcium during the full 15-to 20-year period of his bone growth must not contain more than enough strontium 90 to deposit 80 units in the bones.

What matters is not the strontium 90 content of the food at any one time, but the average level over the whole 15-to 20-year period. It is not yet known exactly what portion of the dietary strontium 90 is taken up by the body; it may be as little as one-half or as much as all of the strontium 90 in the food.

Every person who exceeds the maximum permissible concentration will not automatically become sick. But if, on the average, a large group of people exceeds the maximum permissible concentration for strontium 90, we may expect detectable evidence of disease in a noticeable proportion of the population.

St. Louis milk showed a yearly average for the period August 1957 to August 1958 of 10.7 strontium 90 units. This represents about one-eighth of the maximum permissible concentration.

The 80-unit maximum, however, is only a rough estimate of how much strontium 90 may be harmful. During the past 10 years, as knowledge of the harmful effects of radiation has advanced, the maximum permissible concentration has been successively reduced on three occasions, so that it now stands at a level which is one-sixteenth of that accepted 10 years ago. There is evidence that the present maximum permissible concentration may have to be reduced further; this would increase the expectation of harm from a given amount of strontium 90.

Actually it is not even known whether there is a threshold level of radiation which can be absorbed by the body with absolutely no expectation of harm. If a

(Continued on next page)

MILK AND THE STRONTIUM 90 PROBLEM – *(Continued from page 1)*

threshold exists, very low levels of radiation might be altogether harmless. But if there is no threshold, any amount of radiation, however slight, increases the chance of medical harm.

In summarizing the hazard, the CNI statement said:

"In the face of these and other uncertainties about the strontium 90 problem, we cannot now predict whether or not this situation will be completely free of future harm. So little is known about the problem that any estimate of the hazard may be five to ten times too high or too low. If all the unknown factors work out favorably, the strontium 90 content of milk will be of negligible significance. If most of these factors work out unfavorably the ultimate level of strontium 90 might reach the maximum permissible concentration, and some medical harm might result from the strontium 90 absorbed by children now growing up. It may take years before we know what danger exists."

3. Milk is an essential food for children.

Milk is the major source of calcium for the growth of bones and teeth. The protein it contains, which is, of the type that nature has provided for the nutrition of all young animals, is ideally suited to meet the requirements of bodily growth. So milk cannot be eliminated from a child's diet without causing serious medical problems.

Furthermore, the CNI statement points out, cutting down milk consumption would probably have no effect on strontium 90 absorption. The amount of strontium 90 absorbed by the body seems to depend on the ratio of strontium 90 to calcium in the diet, and not so much on the total amount of strontium 90 taken in. Nothing can be gained by reducing milk intake, for this will not necessarily lower the decisive strontium 90-calcium ratio in the food. Nor will substitution of other foods be helpful. Although less fully studied than milk, all other foods that contain calcium, such as cereals and vegetables, also contain strontium 90 – sometimes in ratios that exceed that of milk.

4. What can be done?

After stating that the strontium 90 level of milk may turn out to be hazardous, and that the possible hazard cannot be avoided by reducing or eliminating the intake of milk, the statement comes to this conclusion:

"In view of these observations, prudence requires that research be undertaken to increase our knowledge of the strontium 90 hazard and to find ways for reducing the strontium 90 content of milk. As soon as practicable, the results of research on lowering strontium 90 content should be applied to the milk supply."

The Problem Is Widespread

In addition to the U.S. Public Health Service, whose 1958 report on the strontium 90 content of milk caused justifiable alarm in St. Louis, a number of other agencies are studying the strontium 90 content of foodstuffs. The most extensive survey reported so far was carried out by Consumers Union, and has just been published in the March, 1959, issue of Consumer Reports.

Unlike other agencies, which have dealt with powdered milks or have concentrated their efforts on the product of a small group of farms, Consumers Union bought fluid milk at retail outlets. In 50 cities, two quarts of each of four local brands were purchased weekly for four weeks in July and August of 1958. In this way, representative samples of the milk reaching the consumers were obtained.

Analysis of the milks yielded strontium 90 values ranging from 2.3 S.U. at Las Vegas to 15.6 in New Orleans. Except for generally low findings in the southwest, the values varied rather erratically. After New Orleans, the next highest values were found in Bismarck, N.D (14.1) and Boston, Mass. (13.9). St. Louis, with a rating of 11.1 S.U., was above the average of 8.0 S.U.

Evidently local factors which are not now well understood cause significant variations in the strontium 90 content of milk. In many areas the content is already great enough to aggravate a young child's burden of strontium 90 seriously within a relatively short time.

The Consumers Union laboratory report is accompanied by an extensive discussion of the biological implications of the fallout problem. The article brings out the important fact that strontium 90 does not distribute itself uniformly throughout bone, but tends to be localized in "hot spots" in which the deleterious influence may be quite out of proportion to the body's total content of the element. The tendency for radium to concentrate in local areas of bone has been known for many years. The possibility that one highly active spot may initiate leukemia or bone cancer is a principle reason for believing that almost any dose of strontium 90, however small, may be potentially harmful.

Can strontium 90 be taken out of milk?

The problem of separating a mineral element from a fluid medium is basically a simple exercise in analytical chemistry. In recent years a number of new and elegant methods for such separations have been introduced. But the removal of strontium 90 is complicated by its resemblance to calcium. The similarity that allows strontium to substitute for calcium in plant growth, milk synthesis, and bone deposition makes any attempt to extract the unwanted strontium 90 likely to take out the essential calcium too.

A report in the St. Louis Post-Dispatch on Feb. 8, 1959, states that British scientists have developed a method for removing strontium 90 from milk that is considered "highly interesting" by the U.S. Public Health Service. According to the report, "If the British work has progressed beyond the preliminary stage and shows prospects of success, officials have said it is likely they would begin tests of the British process." Whether the British method will remove strontium without calcium has not been reported.

The classical means of removing strontium from milk would be to add to the milk some substance that would form an insoluble compound with strontium. For example, adding soluble sodium carbonate would result in the formation of solid, insoluble strontium carbonate which

(Continued on back page)

A TROPICAL GARDEN - OR A NEW ICE AGE?

COULD the H-bomb be used to warm the northern latitudes and provide the rainfall that would make the deserts bloom? These possibilities have been suggested. But the attempt to use nuclear energy to modify the weather on a world-wide scale might produce an ice age instead.

The earth obtains its energy from the sun. All the energy thus received is radiated back from the earth into space, and so the mean temperature of the earth and its atmosphere does not change perceptibly from year to year. If more of the incident energy could be retained and utilized, the result might be to open large areas of the sparsely settled north to extensive habitation and development. The attractiveness of this possibility has led to the invention of a variety of schemes for trapping more of the sun's energy.

Two Ways to Retain Energy

The energy of the earth might be increased either by increasing the amount of solar energy absorbed by the earth, or by reducing the amount radiated back into outer space. In a recent issue of *Science* (Oct. 31, 1958), H. Wexler has discussed these two possibilities.

Increasing the amount of energy absorbed by the earth could be achieved by blackening the polar ice caps or the deserts with carbon dust. This technique has been used to melt stretches of ice where it was essential for a ship to get through, as in relief operations. But estimates of the amount of carbon dust that would be needed show the impracticability of this scheme. To cover the tropical deserts would require about 500 million tons of dust, and three times that amount would be needed for the north polar ice cap.

Reducing the amount of energy radiated into space could be achieved by the formation of an artificial "ice fog", a dispersion of fine ice crystals in the air. Such fogs form in cold regions when moisture is present in the air; thus the phenomenon may appear in far northern cities where the buildings are heated. The blanket of minute ice crystals is capable of reducing the heat loss from the earth's surface by as much as 80 per cent. As a consequence, the ground surface temperature rises appreciably.

The cheapest and most effective way of forming an ice cloud would be to apply nuclear energy. Wexler estimates that the explosion of ten 10-megaton "clean" hydrogen bombs (equivalent to a total of 100 million tons of TNT) in the Arctic Ocean would form an ice fog large enough to cover most of the area above the Arctic Circle. Such a fog could reduce the outflow of energy into space to one-fifth of its present value. It is thought that prevailing winds would confine the cloud to the Arctic, so that it would not dissipate into southern latitudes. The amount of energy saved by the presence of such an ice fog would be equivalent to the energy released by the explosion of more than fifty 10-megaton bombs every day for an entire year!

What Would Happen?

According to Wexler, the presence of a great fog blanket over the Arctic would have the following effects:

- The average temperature of the earth south of the Arctic Circle would be increased from 2° to 5° F.
- In the equatorial belt there would be increased rainfall. In the middle northern latitudes the winters would become warmer but would be subject to more severe storms and greater precipitation.
- Above the Arctic Circle the melting of the ice cap, already under way, would proceed at a faster rate than at present; it might disappear in as few as ten years.

The disappearance of the ice cap, though it might open the Arctic Ocean to shipping, would not necessarily be a boon. On the contrary, the earth might soon find itself in the grip of a new ice age. How such a disastrous result might come about is suggested by a new theory of the ice ages, recently developed by M. Ewing and M. L. Donn in *Science* (June 15, 1956). This theory, in which the occurrence of an open Arctic Ocean is an essential element, has been described by B. Friedan in *Harpers* (Sept, 1958).

More Moisture in Air

Once the ice cap had melted, the amount of moisture in the atmosphere would be greatly increased. The moisture-laden air, moving over the colder land masses in winter, would precipitate snow. In the short Arctic summers the snow would not melt completely, and so the snow blanket would grow thicker each winter. Meanwhile, the inflow of warm water from the Atlantic Ocean would prevent the polar ice cap from reforming in the Arctic Ocean. Thus, ice would continue to accumulate on the continents until vast glaciers, perhaps as much as two miles high, were formed. These glaciers would gradually move down the continents as in the last glacial epoch, when the ice reached into northern Illinois.

The growth of the glaciers would be paralleled by a lowering of the level of the oceans. Ultimately, the Atlantic would fall about 300 feet, with the result that there would no longer be a sufficient flow of warm water over the Norway-Greenland sill to keep the Arctic Ocean from freezing again. The glaciation process would then at last begin to reverse itself. The snow would melt faster than it formed, the ice cap would gradually accumulate, and the earth would slowly emerge from its first man-made ice age.

Evidently any proposal for changing the weather by means of nuclear energy must be subjected to the most thorough evaluation possible. The result of an ill-considered experiment might be a catastrophe of unprecedented proportions.

MILK AND THE STRONTIUM 90 PROBLEM – *(Continued from page 2)*

could be filtered out of the milk. The difficulty is that calcium would also be removed.

The usual chemical procedure for removing strontium from a solution without removing calcium at the same time is to add a soluble sulfate to precipitate strontium sulfate. Since the number of atoms of strontium 90 in milk is (from a chemist's point of view) very low, it would probably be necessary to add a natural (non-radioactive) strontium compound to effect the precipitation of a significant part of the radioactive isotope as strontium sulfate.

Separation of strontium 90 on resin

These difficulties led to the hope that a more satisfactory procedure might be found in the recently popularized methods of ion exchange, which have worked wonders in facilitating separation of the rare earths, and in permitting chemical identification of the artificial transuranium elements, such as einsteinium, fermium, and mendelevium.

Ion exchange employs synthetic materials, called resins, which are composed of large particles. Although they are insoluble in most solvents, these particles are capable of reacting rapidly with dissolved materials. Some resins react with ions of metallic elements and remove them from solution, the fraction removed differing for each element and each resin. The metallic elements can be recovered from the resin by the addition of a solution, called an eluant, which will react with them. Again the fraction redissolved differs for each element and each eluant.

In the usual experiment for the separation of two elements by ion exchange, a tube or column is filled with an appropriate resin. Compounds of the elements to be separated are placed at the top of the column, and a chosen eluant is allowed to flow down through the resin column. The metallic ions are dissolved from the resin at the top of the column, but the *fresh* resin below tends to re-absorb them. Then *fresh* eluant redissolves the ions and carries them down to meet more *fresh* resin – the process being repeated again and again until the ions have been carried out at the bottom of the tube.

The rate of movement of the ions is determined not only by the rate of flow of eluant, but also by the relative affinities of the resin and the eluant for the ions. These affinities vary from element to element, from resin to resin, and from eluant to eluant. An element for which the resin has great affinity will spend much time *stuck* on the resin and little time moving in the eluant. Thus, it travels down the column at a slower rate than another element for which the resin has less affinity.

If the rates of movement of the elements added to the column are sufficiently different, it is possible that all of one element will be washed out of the column while the other has moved only half-way down; thus complete separation would be effected. Calcium and strontium can be separated in this way, if one uses a particular resin, Dowex-50, and a solution of ammonium lactate as eluant.

The first test of the method

In 1954, AEC Commissioner W. F. Libby, in collaboration with W. E. Nervik and M. I. Kalkstein at the University of California, applied the ion exchange method in its simplest form to the purification of milk. They passed milk through a column of Dowex-50 resin, the milk fluid itself acting as the eluant for the minerals it contains. Most of the strontium-90 was removed from the milk, but unfortunately most of the calcium was removed too. In fact, no significant difference in behavior between strontium and calcium was observed in their experiment. This means that milk is not a satisfactory eluant for separation on Dowex-50.

The method need not be regarded as worthless, however. Some means may be found of adapting it to the problem posed by the presence of strontium and calcium in milk. It is conceivable, for example, that a new resin might be found which would effectively separate strontium but not calcium from milk passing over it. Alternatively, some substance might be discovered which, when added to milk, would decrease its affinity for strontium (or increase its affinity for calcium) without impairing its palatability or its food value. A third possibility, which Commissioner Libby and his coworkers suggested, is to allow the calcium to be removed, and then to make up the deficiency by adding some calcium compound to the treated milk. The difficulty here is that most of the calcium in milk is not present as a simple inorganic salt, but is bound in a complex with phosphate and protein. Whether an artificially added calcium compound would be a completely satisfactory substitute for the naturally occurring complex in the nutrition of infants and young children is not known.

The details of the British method have not yet been disclosed, obviously there are a number of critical questions to be considered: How effective is the method in removing strontium 90? How much will it add to the cost of milk? What effect will it have on the nutritive value of milk? We await the answers to these questions with the greatest interest.

INFORMATION is published 10 times a year by the Greater St. Louis Citizens' COMMITTEE FOR NUCLEAR INFORMATION. Address: 4484 West Pine Blvd., St. Louis 8, Missouri. Telephone: JEfferson 3-0353 (9 a.m. to 12 noon)

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The Committee for Nuclear Information is an organization devoted to the gathering and public distribution of facts about the effects of nuclear war, nuclear testing, and non-military uses of nuclear energy.